

# XMM- $\Omega$ PROJECT : COSMOLOGICAL IMPLICATION FROM THE HIGH REDSHIFT $L - T$ RELATION OF X-RAY CLUSTERS

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**Abstract** The evolution of the temperature distribution function (TDF) of X-ray clusters is known to be a powerful cosmological test of the density parameter of the Universe. Recent XMM observations allows us to measure accurately the  $L - T$  relation of high redshift X-ray clusters. In order to investigate cosmological implication of this recent results, we have derived theoretical number counts for different X-ray clusters samples, namely the RDCS, EMSS, SHARC, 160 deg<sup>2</sup> and MACS at  $z > 0.3$  in different flat models. We show that a standard hierarchical modeling of cluster distribution in a flat low density universe, normalized to the local abundance, overproduces cluster abundance at high redshift ( $z > 0.5$ ) by an order of magnitude. We conclude that presently existing data on X-ray clusters at high redshift strongly favor a universe with a high density of matter, insensitively to the details of the modeling.

**Keywords:** Cosmology, X-ray clusters, L-T relation

## 1. Introduction

In this work we examine the expected number counts with different values for the density parameter and compare them to observed counts. The first model is the best flat model fitting the local Temperature Distribution Function (TDF) as well as the high redshift TDF (Henry, 1997), see Blanchard 2000. While the second model is a flat low density model normalized to the local TDF.

## 2. Ingredients of the modeling and results

As a first step, models are normalized using the local temperature distribution function, two fundamental ingredients are needed: the mass function and the mass-temperature relation,  $M - T$ . Here we use the expression of the mass

$T_{15}$ (keV)	$\Omega_M$	$\sigma_8$	$\Gamma$	Cosmological model and ingredients
4	0.3	1.	0.2	B: Low $\Omega_M$ +BN98+SMT
6.5	0.3	0.72	0.2	B: Low $\Omega_M$ +M98+SMT
4	1.	0.55	0.12	A: best model+BN98+SMT
6.5	0.85	0.45	0.1	A: best model+M98+SMT

Table 1. Models and parameters used in the number counts calculations

function given by Sheth, Mo and Tormen, 1999.

$$f(\nu) = \sqrt{\frac{2A}{\pi}} C \exp(-0.5A\nu^2) (1. + 1./(A\nu)^2)^Q \quad (1)$$

with  $A = 0.707$ ,  $C = 0.3222$ ,  $Q = 0.3$  and  $\nu \equiv \bar{\delta}/\sigma(M)$ .

The  $M - T$  relation is written to be:  $T = T_{15}(\Omega\Delta)^{1/3} M_{15}^{2/3} (1+z)$ .

In this work we use different models of universe, including different  $M - T$  normalizations, presented in table 1.

A key-ingredient of the modelling is the  $L - T$  relation and its evolution. The goal of the XMM-Omega project was to measure accurately this relation at redshift about 0.5 (Bartlett et al., 2001). We estimate the evolution from the recent XMM observations of high redshift clusters (Lumb et al., in preparation), following the method of Sadat et al. (1998), by computing for each cluster :

$$C(z) = \frac{L}{AT^B} \frac{D_l(\Omega_M = 1, z)^2}{D_l(\Omega_M, z)^2}$$

We parametrize the evolution by  $C(z) = (1+z)^\beta$  and we determine the best fitting  $\beta = 0.65 \pm 0.21$ , consistent with the Chandra result (Vikhlinin et al. 2002). In order to compute number counts, one can notice that the observations actually provide  $z$  and  $f_x$  (rather than the actual  $L_x$  and  $T_x$ ), therefore one has to compute the following:

$$\begin{aligned} N(> f_x, z, \Delta z) &= \int_{z-\Delta z}^{z+\Delta z} \frac{\partial N}{\partial z} (L_x > 4\pi D_l^2 f_x) dz \\ &= \int_{z-\Delta z}^{z+\Delta z} N(> T(z)) dV(z) \end{aligned} \quad (2)$$

Results are presented in figure 1. We conclude that *within the standard scenario of structure formation*, the predicted abundance of galaxy clusters points toward a high density universe, insensitively to local  $L - T$  used, to the dispersion on its evolution nor the different  $M - T$  normalization.

## References

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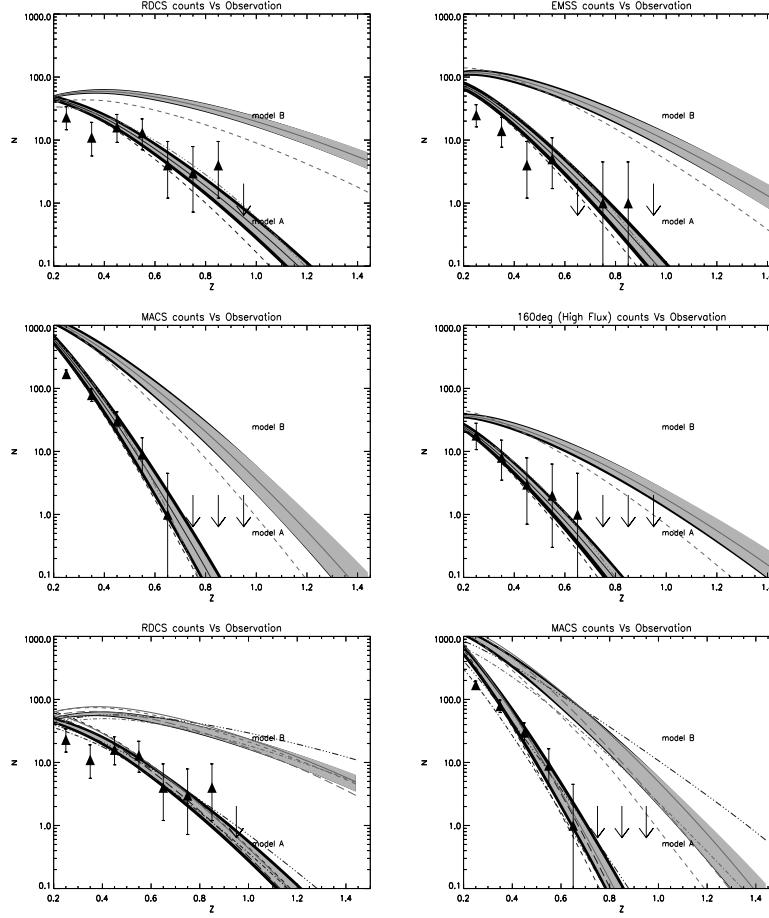


Figure 1. Theoretical number counts in bins of redshift ( $\Delta z = 0.1$ ) for the different surveys: RDCS, EMSS, MACS and 160deg<sup>2</sup>. Observed numbers are triangles with 95% confidence interval on the density assuming poissonian statistics (arrows are 95% upper limits). For the 160deg<sup>2</sup> we show here only the brightest part ( $f_x > 2 \cdot 10^{-13}$  erg/s/cm<sup>2</sup>). The upper curves are the predictions in the concordance model. The continuous lines correspond to  $T_{15} = 4$ , while the dashed lines are for  $T_{15} = 6$ . The grey area show our estimate on the uncertainty in the evolution of the L-T relation. The two last plots show the systematics effect: counts using the Press and Schechter mass function (solid line) and changing the local L-T (slope and normalization dashed lines) from  $0.04T^3$  to  $0.08T^3$  and  $L \propto T^{2.7}$  to  $L \propto T^{3.3}$ .

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